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EARTH SCIENCES

Division

Distinguished Scientist Seminar Series

10:30-12:00 p.m.
Friday, November 7, 2008
Building 50 Auditorium

Electron Transfer Dynamics in the Biogeochemical Cycling of Iron

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Abstract

The chemical behavior of mineral-water and mineral-microbe interfaces is central to aqueous reactivity in natural waters, soil evolution, atmospheric chemistry, and is of direct relevance for maintaining the integrity of waste repositories and remediating environmental pollutants. An important subset of reactions is the exchange of electron equivalents across these interfaces associated with natural variation in redox conditions or the activity of microorganisms at the earth's near-surface. For example, microbially catalyzed reductive transformation of Fe(III)-oxides to solubilized Fe(II) by dissimilatory metal reducing bacteria is a process that can link to and control transport of redox-active contaminants. Detailed microbiologic study has revealed the presence of highly efficient biomolecular machinery for interfacial electron transfer localized on the outer-membranes of these microorganisms. Multi-heme cytochromes with high heme densities appear optimized for efficient interfacial electron transfer. Furthermore, some Fe(III)-oxides specifically utilized by these microorganisms, such as hematite, are natural electrical semiconductors with the propensity to accept and mobilize electrons in support of sustained microbiologic respiration. This presentation will center on current experimental and computational modeling research at PNNL focused on elucidating molecular-scale mechanisms and kinetics of electron exchange across this interface. In particular, the fundamental behavior of electrons in the mineral hematite and at key crystallographic terminations will be discussed. Single-molecule tunneling spectroscopy of microbial outer-membrane cytochromes will be compared with computational molecular modeling of cytochrome/hematite electron transfer. Common aspects of biomolecular and solid-state electron transfer processes at this environmental interface will be highlighted in terms of modern electron transfer theory.

Biographical Sketch

Kevin Rosso is a Staff Scientist and Associate Director in the Chemical and Materials Sciences Division at the Pacific Northwest National Laboratory. Dr. Rosso's research is centered on elucidating the relationships between the atomic and electronic structure of crystalline materials with their reactivity and physical properties, particularly at interfaces, using various concepts and tools of surface science, chemistry, solid state physics, and crystal chemistry. His recent research is focused on unraveling rates and mechanisms of biogeochemical electron transfer towards a better understanding of subsurface contaminant transport. Dr. Rosso has published 80 peer-reviewed publications and several book chapters on various molecular-scale aspects of mineral/water and mineral/microbe interface chemistry.

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